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Title: Performance Evaluation Of Rotary Power Weeder For Coffee Plantation

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Abstract*—Coffee production has increased in recent years due to the economic value of the crop and the importance of coffee market in the globe. This increase is made possible by numerous research advances made along the entire value chain. However scientific research has been focused mainly on production whilst neglecting cultivation issues. Weed control is one of the most difficult tasks in coffee farm that accounts for a considerable share of the cost involved in production. Weeding is the removal of unwanted plants in the field crops, mechanical weed control is very effective as it helps to reduce drudgery involved in manual weeding, it kills the weeds and also keeps the soil surface loose ensuring soil aeration and water intake capacity. Weeding is an important but equally labor intensive agricultural operation. There is an increasing interest in the use of mechanical intra-row weeders because of concern over environmental degradation and a growing demand for organically produced coffee. This study was conducted to evaluate the performance of rotary power weeder on farmers' field in Mana district Haro kebele of Jimma zone on garden and plantation coffee where we can find garden and plantation coffee production in our vicinity. The implement had been evaluated in three different speeds in the village of Haro of Mana during the 2016/2017 cropping season. It had been evaluated in garden and plantation coffee in intercultural operation on farmers' fields. The weeding operation was carried out at the weeds mean height of 0.3 m after its emergence. The mean coffee plant population, average weed population, weeding efficiency, depth and width of working, average speed of operations had been measured. The effective field capacity and the cost of operation had been calculated in different operation speeds. The overall performance of the implement was found satisfactory in weeding operation of coffee plants in farmers' fields. The average effective field capacity in different operation speeds of it were 0.03, 0.04 and 0.05 ha/h respectively. Therefore the implement had been recommended in row planted coffee crops as it gave a higher field capacity (0.05 ha/h) and higher saving in the cost of operation and labor requirement over the traditional manual weeding.

Keywords—mechanical weed control, coffee plants, weeds

Introduction

Coffee is the major category of the Rubiaceae family, which has over 6000 species. Of many species that are found in the coffee family, only 2 are presently regarded with importance- coffee Arabica and coffee Robusta. About 70 countries worldwide produce coffee and to these countries, not only is coffee a major means of foreign exchanges, but also responsible for tax income and gross domestic product (GDP). Ethiopia is Africa's first coffee producer. Coffee export is the main source of foreign exchange and also a large segment of the population is involved in the coffee industry (MOA).

Coffee production system in Ethiopia: there are four type of production system in Ethiopia: forest coffee, semi-forest coffee, garden coffee and plantation coffee. Forest coffee offers high yields and top quality in terms of aroma as well as flavor and it accounts for about 10% of the total coffee production, semi-forest coffee accounts for about 35% of the coffee production, garden coffee accounts for about 50% and plantation coffee accounts for about 5% of the total production.

Coffee is the major agricultural export crop, providing currently 35% of Ethiopian foreign exchange earnings down from 65% a decade ago because of the slump in coffee prices since the mid-1990's.Coffee cultivation plays a vital role both in the cultural and socio-economic life of the nation. About 25% (23.5 million) of Ethiopian population depend, directly or indirectly, on coffee production, processing and marketing, (Woods 2003). The estimated coffee production area (2% of total cultivated land) in the country is measured in the range of 320,000 to 700,000ha (FAO, 1987), though potentially there exist about 6 million ha cultivable land suitable for coffee plantation.

The trees are planted in rows about twelve or fifteen feet apart and comparatively little attention is given to cultivation. Coffee cultivation in general today the commercial growers of coffee on a large scale practice intensive cultivation methods, giving the same care to preparing their plantations and maintaining their trees as do other growers of grains and fruits, so every effort is made to obtain the maximum production of quality coffee consistent with the smallest outlay of money and labor. After the young plants have gained their start they should be cultivated frequently 2 to 3 times in a year principally to keep out the weeds, to destroy pests and to aerate the earth, but farmers slash the weeds

once in a year to facilitate harvesting of coffee beans. Production is mostly governed by the cultivation given the tree, by climate, soil and location, supervision of quality coffee begins with the seedlings and ends when the coffee is shipped out to the international market (Ethiopian ministry of agricultural).

One of the positive things about Ethiopian coffee is that the majority of it is organically produced, however organic certification is extremely difficult to obtain so the coffee cannot be sold as "organic". An average coffee harvests under research, private investors and traditional farmers conditions are at the threshold of (10 - 20 q/ha), (8-12 q/ha), 4.5 q/ha of clean coffee beans respectively.

Weed control is one of the most difficult tasks in coffee farm that accounts for a considerable share of the cost involved in production. Weeding is the removal of unwanted plants in the field crops, mechanical weed control is very effective as it helps to reduce drudgery involved in manual weeding, it kills the weeds and also keeps the soil surface loose ensuring soil aeration and water intake capacity Lavabre (1991).

Weeding is an important but equally labor intensive agricultural operation. There is an increasing interest in the use of mechanical intra-row weeders because of concern over environmental degradation and a growing demand for organically produced coffee. Today the agricultural sector requires non-chemical weed control that ensures food safety and consumers demand high quality food products and pay special attention to food safety. Though the technical development of mechanisms for physical weed control, such as precise inter- and intra-row weeders, it might be possible to control weeds in a way that meets consumer and environmental demands. These mechanisms contribute significantly to safe food production (Fogelberg & Kritz, 1999; Kurstjens & Perdok, 2000; Blasco et al., 2002).

The common practice that the farmers use to remove weeds from the crop is traditional weeding using different hand tools such as hatchet and sickle which is labor intensive, drudgery, time taking, demands intensive power inputs where as mechanical power can increase worker's motivation and status while enabling more land to be cultivated with reduced demands on human energy inputs. Some trials had been done before in introducing of draught animal power cultivator on row planted crops such as maize and sorghum in east Shewa and Jimma zone, but so far no mechanical weeder (cultivator) had been introduced around Jimma zone even in private investors' coffee plantation areas.

These state of conditions and related issues initiated me to write this experiment and try under our local condition.

Objective of the study

General objective: To evaluate the performance of a rotary power weeder for coffee plantation.

Specific objectives

- To enhance the use of farm machinery for eliminating weeds from the crop land.
- To promote plant growth and better quality crops.
- To meet the yearning needs of small scale coffee producing farmers.
- To save farming labor by minimizing tedious weeding by hand.

Material and method

The performance evaluation had been conducted on farmers' field in Mana district Haro kebele of Jimma zone on garden and plantation coffee where we can find garden and plantation coffee production in our vicinity. The implement had been evaluated in three different speeds in the village of Haro of Mana district during the 2016/2017 cropping season (Table I). The climate at each site is characterized by a rainy season from April to June when moderate of the rainfall.

The trial was laid out in an on fully randomized design; each plot was 50 m wide by 50 m long without replication at each site. Coffee was planted in 2 m intra row and inters plant spacing at both sites. Weeding operations were planned to be undertaken at the mean weed height of 0.3 m after its emergence.

During each weeding operation, the speed of operation was measured by observing the time taken to travel over 50 m, the Depth and width of soil disturbance had been recorded (three measurements per plot), total time spent on each site were measured, plant records included Coffee plant population, weed population and hiring charge of traditional manual labor was Birr 1200/hectare.

The weeding efficiency was determined by counting weed samples before and after the cultivating (Sample size 1 m^2, three repetitions per plot.), and weeding efficiency was calculated by the relative difference between total weed before (M_1) and after (M_2) weeding treatment.

Weeding efficiency (%) = $[(M_1\text{-}M2/M_1)] \times 100$

Table I. Brief specification of performance evaluation in different operation speeds (RPM)

Particulars	RPM		
	1250	1550	1750
Width of coverage (mm)	400	400	400
Depth of intercultural (mm)	15	15	15
Filed Capacity (ha/hr)	0.03	0.04	0.05
Test duration	4.63	3.86	3.51

The following observations were collected /recorded from farmers' fields during intercultural operation.

1. Field Observation: location, size and shape of the field, coffee plant population and intra row and inter

plant spacing, presences of weeds in the field area and its mean height.

2. Operating conditions: width of coverage, operating depth, speed of travel, time required to complete the operation and labor requirements.

Figure1. **Illustrations of rotary power weeder**

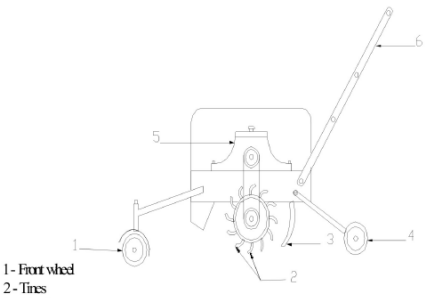

Fig. 2: Shematic illustration of Rotary Power Weeder

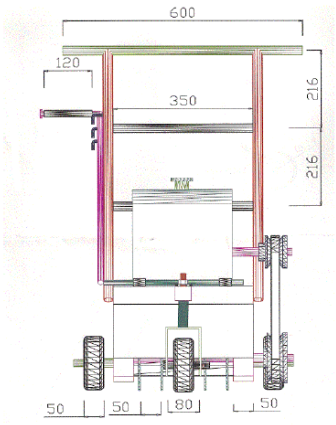

Fig. 3: Front View of the Rotary Weeder

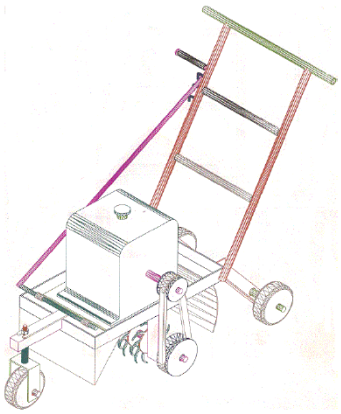

Fig. 4: Rotary Power Weeder

Result and discussion

The performance evaluation of the implement had been discussed below

The implement had been evaluated in garden and plantation coffee in intercultural operation on farmers' fields. The weeding operation was carried out at the weeds mean height of 0.3 m after its emergence (Table II). The mean coffee plant population, average weed population, weeding efficiency, depth and width of working, average speed of operations had been measured. The effective field capacity and the cost of operation had been calculated in different operation speeds. The results had been given in Table II. Results for the various measured and calculated parameters had been also given in Table II.

Table II. Comparative Performance of the implement in different operation speeds

No	Particulars	RPM		
		1250	**1550**	**1750**
1	Area covered (ha)	0.17	0.17	0.17
2	Test duration (hr)	4.63	3.86	3.51
3	Row-row spacing (mm)	2000	2000	2000
5	Mean plant spacing (mm)	2000	2000	2000
6	Mean plant population (No/m^2)	0.5	0.5	0.5
7	Mean weeds height (mm)	300	300	300
9	Mean weed population (No/m^2) - Before cultivation - After cultivation	375 52	375 41	375 30
10	Weeding Efficiency (%)	86	89	92
11	Depth of operation (mm)	15	15	15
12	Working width (mm)	400	400	400
13	Mean speed of operation (m/s)	0.25	0.3	0.33

14	Effective field capacity (ha/h)	0.03	0.04	0.05
15	Labor requirement (Man/ha)	1	1	1
16	Cost of operation (Birr/ha)	754.2	502.4	377.1
16.1	Labor	360	240	180
16.2	Fuel	344.2	229.4	172.1
16.3	Lubricant	50	33	25
17	Length of the row (m)	50	50	50

Conclusion and Recommendations

The overall performance of the Rotary power weeder was found satisfactory in weeding operation of coffee plants in farmers' fields. The average effective field capacity in different operation speeds of it were 0.03, 0.04 and 0.05 ha/h respectively.

The following conclusions had been drawn from the results presented above.

The implement had given a better field capacity in high speed of 1750 rpm (0.05 ha/h) and higher saving in the cost of operation over the others speeds. So it had been recommended for popularization in row planted coffee crops as it gave a higher field capacity (0.05 ha/h) and higher saving in the cost of operation and labor requirement over the traditional manual weeding.

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